Space Weather Technical Forecast

Issued on Thursday 3 October 2024 at 13:12 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1-R2 Blackouts expected, chance of further R3 Blackouts. G1-G2/Minor-Moderate Geomagnetic storms likely, Slight Chance G3/Strong storm days 2 and 3 (04-05 Oct).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with a number of M-class flares in the past 24 hours all of which appear to be emanating from AR3842. The largest event was an M3.3 observed at 02/2051 UTC from AR3842.

There are currently eight active sunspot regions on the visible disc. The most complex region remains AR3842 near south centre disc, which consist of two delta spots. The second most complex region is AR3841, in the northwest close to centre disc, with an elongated delta spot in the trailing portion. AR3848, close to the northeast limb, is the largest region, but its classification remains difficult to analyse due to the foreshortening effect. AR3843 and AR3844 in the southwest are also of note, both with moderate magnetic complexity. The remaining regions on the disc are smaller and appear to be relatively benign.

A filament eruption was observed 03/0630 UTC in SDO/AIA 304 and GONG imagery, close to AR3848 in the northeast. This has produced a CME off the northeast limb, which is yet to be analysed.

The X7.1 flare from AR3842 produced a CME, with an Earth-directed component expected later in the period.

Solar Wind / Geomagnetic Activity: Solar wind parameters were indicative of a slow regime. Solar wind speeds ranged between 290 and 380 km/s. Density was below average. The Interplanetary Magnetic Field, Bt, remained at weak levels, peaking at 7nT. The north-south component Bz, remained at weak values below +/-6nT. Phi angle was mostly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels (at diurnal peak), with a peak value of 258 pfu at 02/1525 UTC. The associated 24-hour fluence was below the Active threshold. The 03/0000 UTC observation was 6.09e6 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Moderate, with further M-class flares expected and a chance of returning to High should another isolated X-class flare occur, these most likely originating from AR3842 or AR4841.

Solar Wind / Geomagnetic Activity: Slight chance of a glancing CME from 29 Sep on day 1 (03 Oct). Likely shock and glancing blow from the X7.1 flare CME from 01 Oct on days 2 or 3 (04-05 Oct). In the absence of any CMEs, solar wind speeds should remain slow-ambient.

Quiet (Kp 0-2) geomagnetic conditions are expected days 1-2. There is a slight chance of Active to G1/Minor storms (Kp4-5) day 1 (03 Oct) from a possible glancing blow from the 30 Sep CME. Later day 2 and during day 3 (04-05 Oct) the possibility of the X7.1 CME arrival sees a likelihood of G1-G2/Minor-Moderate Geomagnetic storms and a slight chance of G3/Strong Geomagnetic storm.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is forecast to persist at background with a slight chance of rising above should further significant flares occur. High energy electron flux at GOES16 is expected to persist at Background to Moderate levels. The associated 24 hour fluence is expected to remain below the Active threshold (1e8 total pfu), throughout.

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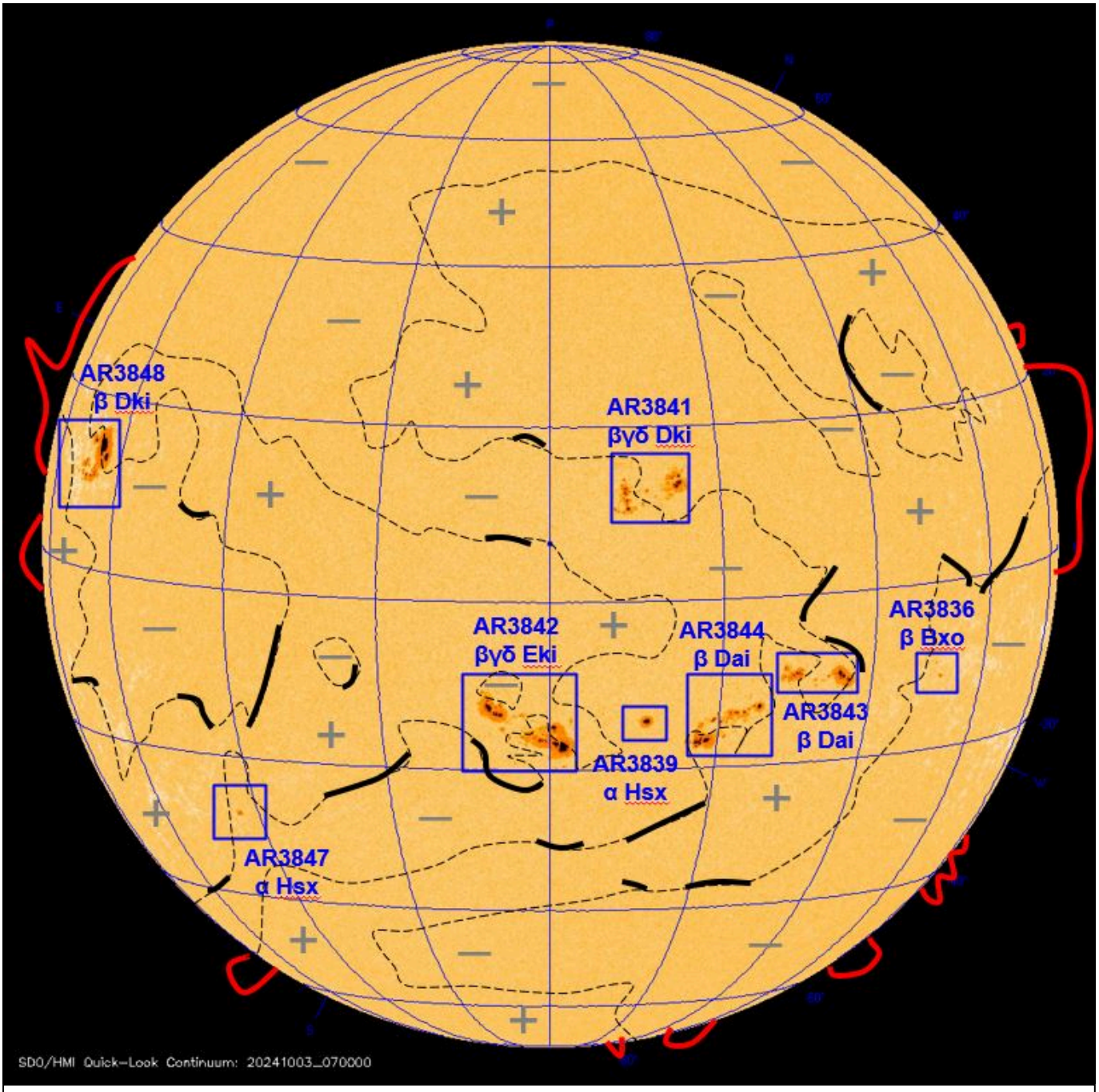
Figure 1: Solar synoptic map - valid 03/0700 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A CME was observed leaving the Sun around 30/1545 UTC, this fast CME will mostly miss Earth however there is a small chance of a glancing blow on day 1 (03 Oct). A CME was seen to the south and southeast of the disc associated with the X7.1 flare on 01/2220 UTC, with a full halo shock. Analysis based on radio emissions and the sunspot's location suggests arrival time later day 2 (04 Oct) or more likely during day 3 (05 Oct), though the arrival window remains low confidence.

In the absence of any CMEs, solar wind speeds should remain at slow-ambient over coming days. MOSWOC Enlil and Enlil ensemble currently display a possibility of a glancing blow from the aforementioned CMEs.

Quiet (Kp 0-2) geomagnetic conditions are expected on days 1-2 (03-04 Oct). However, there is a slight chance of Active (Kp4) periods or G1/Minor Geomagnetic storm intervals (Kp5) occurring on day 1 (03 Oct) due to a possible glancing blow of the 30 Sep CME, although this is low confidence. Later on day 2 and during day 3 (04-05 Oct) the possibility of the CME arrival (associated with the X7.1 flare on 01 Oct) sees a likelihood of G1-G2/Minor-Moderate Geomagnetic Storms and a slight chance of G3/Strong Geomagnetic Storm interval should a more direct hit occur.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	20	50	60	5
Strong	**G3**	No	1	15	20	1
Severe	**G4**	No	1	5	5	1
Extreme	**G5**	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
30/1545	Partial	Filament	SW	1500	03/0300UTC	Glancing blow. Low confidence.
02/0938	Partial	AR3842	SE	800	04/2300 UTC	Low confidence based on estimates. +/- 12hrs arrival time.

Figure 2: MOSWOC Enlil - shows the arrival of the 01 Oct CME either late 04 or early 05 Oct.

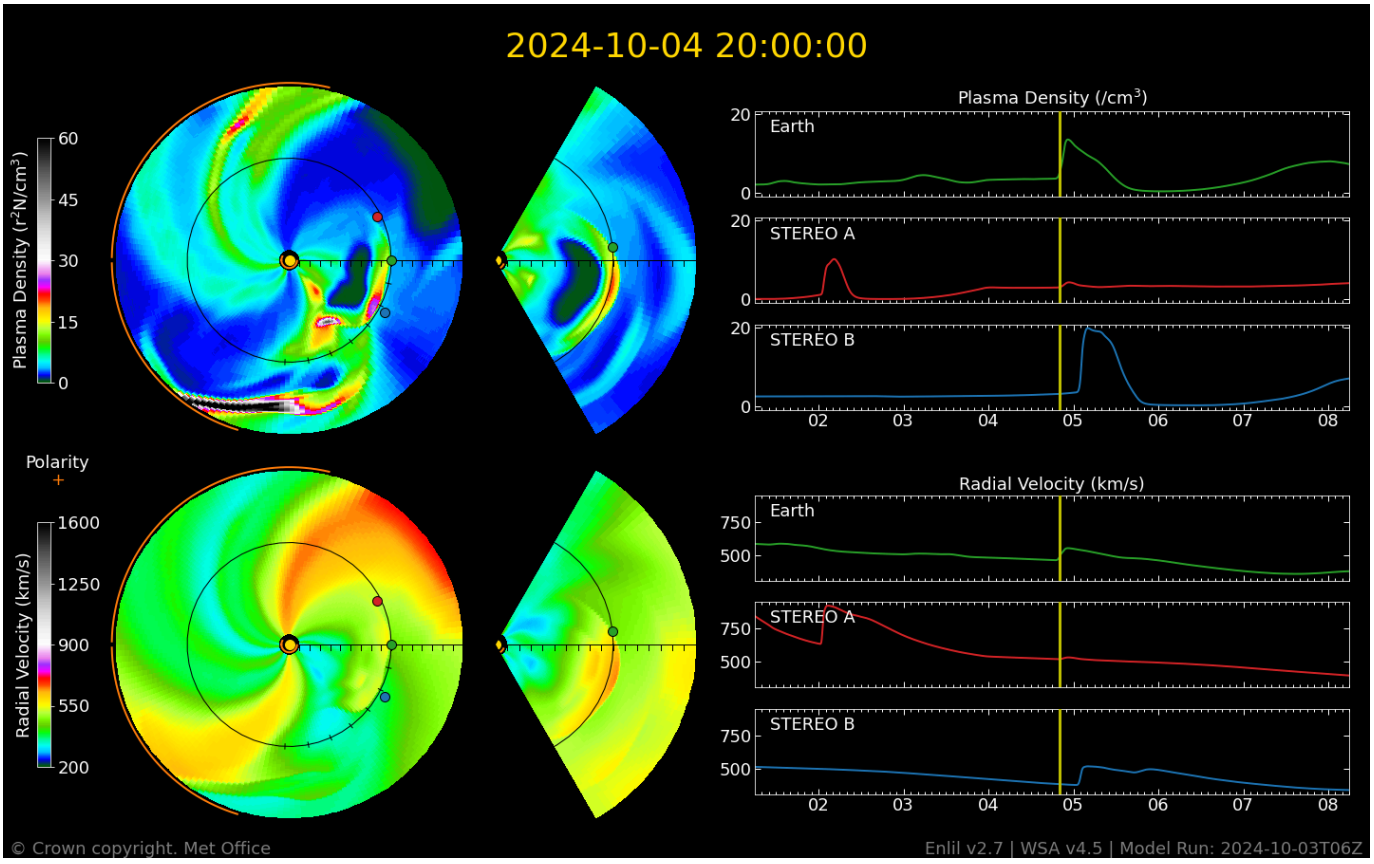

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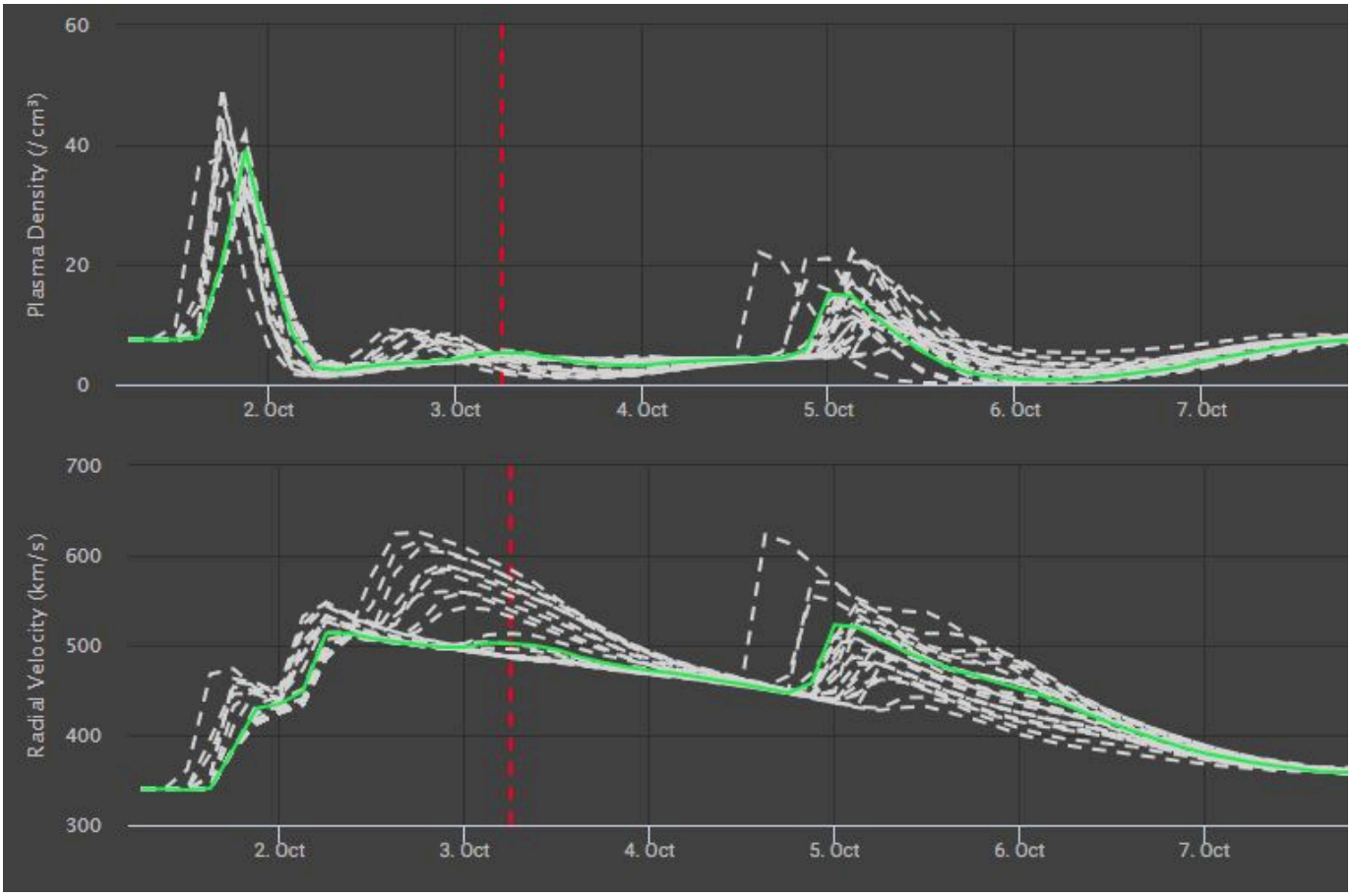
Figure 3: MOSWOC Enlil Ensemble.



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Radio Blackouts - X-Ray Flares

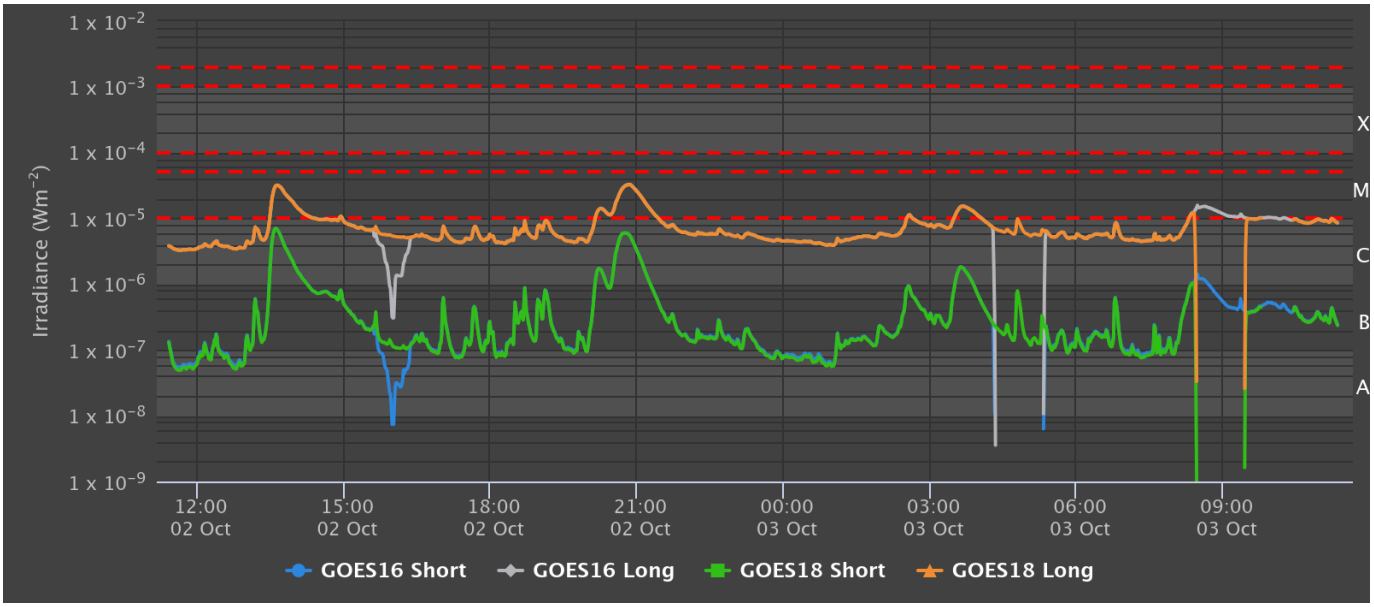
Solar activity has been Moderate with a number of M-class flares in the past 24 hours all of which appear to be emanating from AR3842.

There are currently eight active sunspot regions on the visible disc. The most complex region remains AR3842 near south centre disc, and consist of a delta spot in each of its trailing and leading portions, the latter of which is much more distinct. The second most complex region is AR3841, in the northwest close to centre disc, with modest growth and retaining an elongated delta spot in the trailing portion. AR3848, close to the northeast limb, is the largest region, with one large leader followed by several trailing portions, but classification remains low confidence due to foreshortening. AR3843 and AR3844 in the southwest are also of note, both with moderate magnetic complexity. The remaining regions are smaller and appear relatively benign.

Solar activity is expected to be Moderate, with further M-class flares expected and a chance of returning to High should another isolated X-class flare occur. The risk of strong flares comes mostly from AR3842 or AR3841, with forecast values held higher than raw probabilities due to past events and the strength and positioning of deltas in each of these spots.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	70	70
Very Active	R3-R5 (X Class)	No	30	30	20	20

Figure 4: GOES16-18 X-Ray flux trace.



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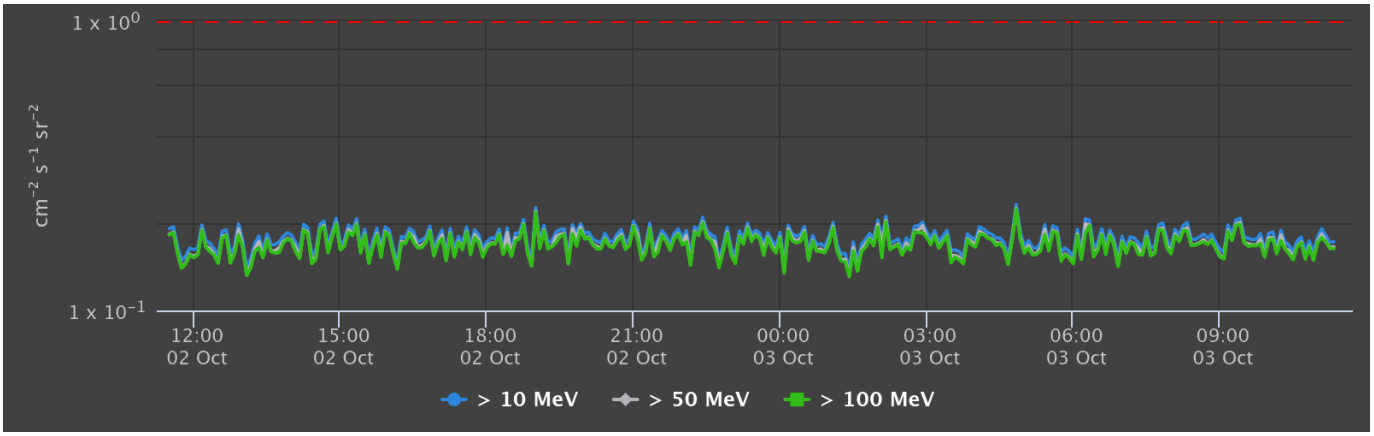
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is forecast to persist at background levels. No notable proton enhancement was observed following the X7.1 flare and associated CME. There is a continued slight chance of Proton rich flares, mainly from AR3842 or AR3841, along with notable filaments on the disc also posing a risk should they erupt.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES16 24-hour Proton trace.



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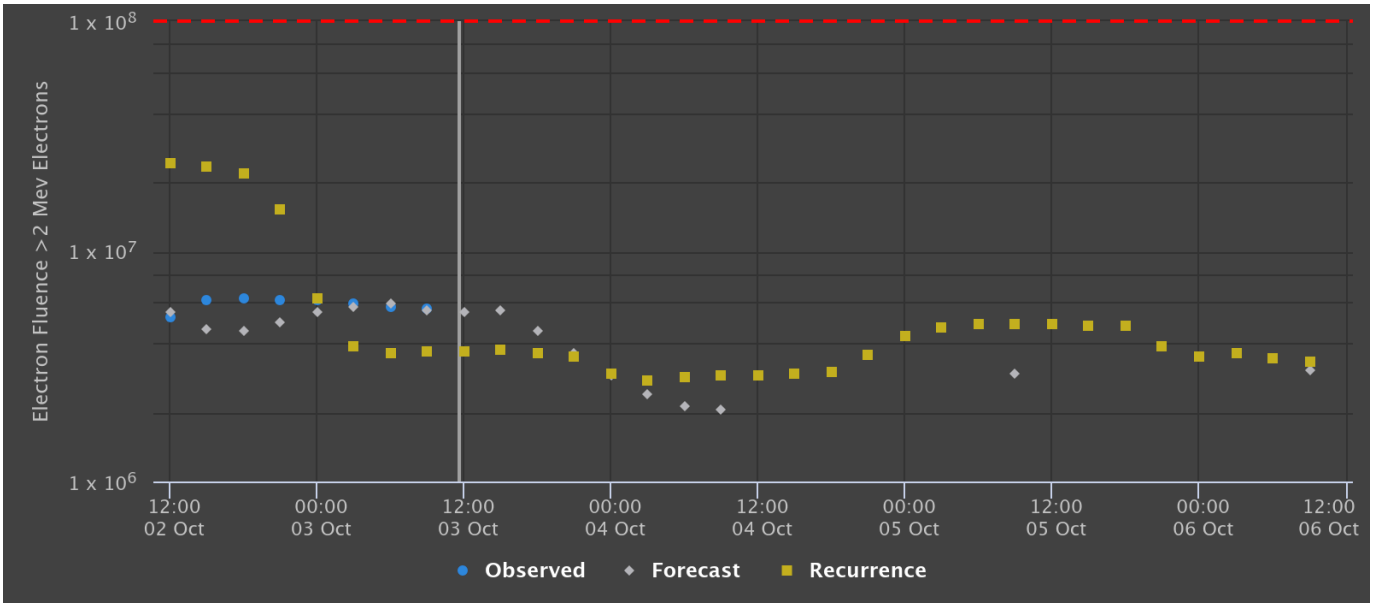
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) observed by GOES16 was at background to Moderate levels (at diurnal peak), with a similar trend expected through the four day period.

The associated 24 hour fluence is forecast to stay below Active (1e8 total pfu), in agreement with MOSWOC REFM.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM integrated flux/fluence forecast, observations, recurrence.



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